

MINT OF THE UNITED STATES,

MELTING & REFINING DEPARTMENT,

Philadelphia, 10th June. 1879

Sir

I herewith offer you the results of the Experiments made with M^r A. E. Outerbridge's apparatus on volatilization of standard silver, & its recovery from vapor, within the last two weeks. The following statement of the amount worked, & produced, & of apparent wastage, will exhibit the whole operation.

Amount worked		<u>St. oz.</u> 17,629.38
Ingots delivered	<u>St. oz.</u> 17,278.68	
Bars, tops, & filings, of ingots	280.99	
Grains gathered (with 1000 Gold)	.99	
Grains gathered from volatilization	1.01	<u>17,561.67</u>
apparent wastage		<u>67.71</u>

It is extremely annoying that the very large apparent wastage of $67\frac{71}{100}$ oz. should have occurred in experimental melts. We are ~~shocked~~ ^{at pained} by its occurrence

one or more times every month, & having proved
Hon A. Loudon Snowden Suptt. over

$$17.629 \cdot \frac{100000}{48145} (.0567)$$

& over again, that it has been due to misredding or misre-
 cording weights, oftentimes to intermixture of different lots
 or parts of lots, in our crowded vaults, & finding that such
 results do not exhibit themselves at our settlements, we
 are obliged to rest content with them, & the anxiety they
 engender, until we can devise some improvement to the ^{different}
^{in successive} ^{daily} workings. Thus the average loss on
 rid of the anomaly of alternate loss & gain. This is certain
 daily workings last year was about $\frac{107}{100}$. Whereas at the annual settlement it was only $\frac{1000-15}{100}$ or
 that Mr. Outerbridge's apparatus or process is not respon-
 sible for the error.

Throwing this ^{irregularity} ~~consideration~~ aside for the present in order to examine Mr. Buterbridge's results & conclusions, ^{1. small amt. volatilized} ^{apparent} and assuming the average daily wastage observed during the past year in melting ingots, say .000-75, ^{which} ^{would be} or in this case about 13 ounces, - we are struck with the small amount volatilized, 1 oz., or $\frac{1}{13}$ of the apparent wastage. ~~Since only standard metal only was employed, our conclusion, is that in melting standard metal~~ ^{silver} From ^{the single alone} ~~this trial by Mr. Buterbridge~~ we learn that in melting silver from within the melting pot ⁽¹⁰⁰⁰⁰⁰⁾ the amount volatilized ^{more exactly} is only (.000-037) of the whole amount worked. This conclusion ^{alone} is of value, & should be & will doubtless

in the ~~main~~ ^{of more or} be confirmed by further experiment, for I think we may safely assume that he ~~recovered~~ ^{the silver} all that vaporized from the interior of the pot. The following table will show the proportion he saved of the whole actual & final wastages of the ^{two last} ~~years~~ years.

On settlement 30 June 1877	wastage of silver	.000-25
" " 1878	" "	.000-15
Volatilized silver condensed by Outer bridge		.000-06

This The principles involved in his ~~apparatus~~ apparatus are quite sound, & the results satisfactory.

In regard to the apparatus, I am disposed to iterate what I think I said before, that it only requires a little time & ^{thoughtful} practice to perfect ~~the~~ its, ~~so as to make it~~ & adapt ^{it} to general use, and I hope ~~that~~ Mr O. may be encouraged to do so.

I have avoided ~~a comparison of the~~ & a conclusion as to the actual amount saved by Mr O's ^{in comparison with our own work} ~~process~~ apparatus, ^{1st} because it is ^{his apparatus} yet ~~it~~ will be yet further improved, & ^{2nd} because we actually save a portion of the vapors arising from the surface of melted silver in the pot, by closing the drafts of the furnace ~~in~~ when at work, so that some of the ~~the~~ vapor certainly escapes into the air of the room, fall on & is ^{daily} swept up from the floor to pass into the sweep. We ^{only} know this ^{absolutely} fact, but ~~nothing~~ of the amount so saved, Nevertheless, ^{we would doubtless save} ~~it would be far better to save~~ ^{for more & with more certainty} by ~~a good~~ an arrangement

$$\begin{array}{r} 450 \\ 16 \end{array}$$

$$\begin{array}{r} 225 \\ 2709 \\ 410 \\ 7425 \end{array}$$

$$\begin{array}{r} 147 \\ 74 \\ 1323 \end{array}$$

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34. When we examine the ratio of the amount ^{of silver} volatilized, from within the melting pot to the amount of wastage at the end of a year (as shown ^{above} in Sec. 2)

2) 6 to 15 or 25 } we know that $\frac{.000 \text{ of } 9 \text{ to } 19}{100000}$ have

been lost in other ways, & since we have carefully gathered all the fragments & dust from every ~~source~~ locality within our reach, ~~we~~ I think we must draw the conclusion that the loss is ^{largely} due to volatilization from the body of the furnace, & therefore from metal spilled, ^{in it} ~~or leaking from the crucible~~. We are subject continually to spilling & ~~spilling~~ ^{particles of} ~~the melted~~ in ladling it out to cast, and ~~these~~ the remainder of these particles we get from the ashes, from the lining of the furnace, &c. ~~That~~ That which adheres to the sides of the furnace is for a long time exposed to the draft of air passing up through the furnace at a bright red heat, & some of it must be volatilized. I have long been aware of this & have ~~been somewhat~~ ^{altho} ~~successful~~ in ~~dim~~ endeavored to diminish this personal error of a melter, ~~with some success~~ yet improvement in this direction is much needed, & can only be most successful in ^{pouring & not instead of} ~~not~~ ~~ladling out of~~ the ~~pot~~ melting pot. Mr O's experiments have confirmed my conclusions. It is this view that (that most of the loss is due to accidental spilling, in spite of extreme care), that led me long since to recommend the construction of condensing chambers, where all volatilizing matters would condense & be gathered,

from whatsoever they arise. While I admire Mr O's principle & the general nature of his ^{improvement}, & wish to see it perfected & brought into use, I still think ^{condensing} the chambers should also be employed; for we can hardly overdo the work of saving in treating gold & silver.

5. In regard to Mr O's apparatus, I am disposed to iterate ^{formerly} what I said ~~to~~ that it only requires a little time & thoughtful practice to perfect its adaptation to ~~general use~~ a more economical working of the precious metals for coinage; and that even now it is well suited to determine ~~questions of~~ the reasons of loss in melting the precious metals & ~~then~~ remedy for the loss. I respectfully draw attention ^{his discovery of} ~~to the~~ ⁱⁿ ~~unlooked for result of~~ using the present form ^{his} of ~~hood~~, viz. that it actually diminishes the draft of air over the surface of the melted metal, & hence tends to diminish ^{its} volatilization; for I am well satisfied from long & varied observation, confirmed by that of others, that a current of any gas or vapor over the surface of ^{melted} gold or silver, & especially of the latter, ~~at a~~ will ~~carry~~ inducingly carry up ~~that~~ small quantities of that metal to be ^{partly} deposited in the flue & partly ~~into~~ ^{into} thrown into the air ^{outside} ~~of the~~

From the ^{above} statement ~~It just made~~ there are several inferences of value.

(over)

1. By comparing the amount gathered from volatilization, ^{.36 oz.} which I think may be assumed safely to be all that volatilized from the metal within the crucible, with the ^{total} apparent wastage 68.36 oz. ~~there~~ it is at once manifest that wastage is ~~due~~ almost wholly due to spilling of metal in various ways into the fire. ~~The~~ The experiments on volatilization are valuable, if only to settle this single point. It is true that in our daily workings, the above wastage is 4 or 5 times as ^{much as} in our daily workings, & I have ^{the excess} shown that is to be ascribed chiefly to the iron ring of the ^{experimental} apparatus narrowing the mouth of the crucible & making it difficult to ladle out metal without striking the ring, & so projecting or dropping ^{a little} ~~some~~ metal into the fire. But some of the excess ^{of wastage is most likely} ~~may be~~ due to the extreme difficulty of keeping the grains of each day or operation, apart from others ^{grains} in the confined space in the sweep cellar. The ~~presence~~ of exceeding smallness of the grain bar, about 1 oz., & the presence of gold in it, show to me that the true grains of the experiment have mingled with others nevertheless, if we assume the wastage to have been as usual in our daily ^{silver} ~~operation~~ ^{melting}, the important ~~say~~ 10 @ 18 oz., ~~still~~ the important conclusion is clear that nearly all the

The apparent wastage of $68\frac{2}{3}$ oz. is extremely annoying especially in ~~an~~ experimental melting, & led me to examine the subject minutely, to discover the cause. The only conclusion that I can safely draw is that which I have often ~~attained~~ ^{proved} in our ^{large} daily meltings that, occasional errors in weights, ~~reading or recording~~ ^{occasionally} & accidentally mingling of parts of different lots, ^{more or less of filling} into the fore, are the chief. I think I may say, the only causes of the irregular returns of wastage, & that the present case is an instance. I believe it is that when carefully ~~wind up accounts~~ close a series of accounts the total wastage is ~~very much lowered~~ materially diminished.

By throwing aside ~~to attain~~ the apparent wastage for the purpose of examining Mr. Outerbridge's ~~accounts~~ ^{in melting pigots} experiment, & adopting the general average wastage $\frac{1}{1000} = 75$ ^{about 13 oz.} ~~the 1st inference of importance drawn from his experiment is that~~

Undoubtedly Mr. Outerbridge's apparatus ^{or} process ~~are~~ ^{is} not responsible for the excessive wastage.

The most striking fact is ~~that in the~~ the exceeding small amount volatilized, ~~26~~ ²⁶ $\frac{3}{8}$ of an ounce, compared with the large amount of usual apparent wastage 13 oz. I can see no room for any fallacy whatever in the working of Mr. Outerbridge's apparatus principle.

